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REVIEWS.

The Economic Geology of the United States. By R. S. TARR, Assistant Professor of Geology at Cornell University. 8vo, 509 pp. Macmillan & Co., 1894.

THIS volume discusses the ore deposits and other minerals and rocks of commercial value found in the United States, as well as a few of the foreign deposits of a similar nature. The book is divided into three parts. Part I. treats of the general mineralogical, geological and technical subjects more or less directly related to the various mining industries. It gives, first, a chapter on "Common Rock and Vein-Forming Minerals," followed by chapters on the "Rocks of the Earth's Crust," the "Physical Geography and Geology of the United States," the "Origin of Ore Deposits," and "Mining Terms and Methods." Part II. treats of "Metalliferous Deposits," including the ores and deposits of the useful metals. Part III. treats of the "Non-metallic Mineral Products," such as coal, petroleum, fertilizers, building stones, etc. In addition, the volume also contains a short appendix on the "Literature of Economic Geology." The object of this volume, as stated by the author in the preface, is to supply the pressing need of a text-book to accompany a series of lectures given by him to a class of students in economic geology at Cornell University.

The book is beautifully printed and neatly bound. The illustrations are well reproduced, and, in fact, all of the publishers' work on the book is very good and reflects credit on Macmillan & Co. The book is written in good language, and the general scheme in the arrangement of the subject matter is logical, but the text is deficient and contains many erroneous statements. The chapters on the "Rocks of the Earth's Crust" and on the "Physical Geography and Geology of the United States," give a fair general idea of those subjects, although even here there are a number of inaccuracies. The chapter on "Common Rock and Vein-Forming Minerals" and parts II. and III. of the book, treating of "Metalliferous Deposits" and "Non-Metallic Mineral Products," however, relate more especially to economic geology, and are the essential features of the volume. They, therefore, deserve consideration in some detail.

The most important feature of a book of this kind is the discussion of ore deposits, yet at the outset a faulty definition of the term "ore" is given. The author says, on page 15, "an ore may be defined as a mineral with a metallic base." Unless further qualified, this definition is, to say the least, vague, for though all ores have metallic bases, there are a number of important minerals with metallic bases which are not ores. Thus, oxide of iron, sulphide of lead, sulphide of copper and other materials have metallic bases, and under proper conditions are ores; but gypsum, calcite, baryta, mica, and many other minerals have metallic bases and are not ores. Moreover, though many ores are minerals, many others are not minerals at all, but are common rocks having some special metallic constituent as their only unusual feature. Thus the ore of the Calumet and Hecla copper mines is a cupriferous conglomerate, the Mansfeld copper deposits of Germany are cupriferous shales, and many other similar instances might be mentioned. The author adds that, "properly speaking, the metallic constituent should be a predominant constituent." Though in some ores the metallic constituent is a predominant one, yet in some of the most important ores the metal forms only a small, and often an insignificant, constitutent. In most gold ores the metallic constituent forms but a fraction of one per cent. of the ore, and in most silver ores the silver forms but a slightly larger amount. In copper deposits, the copper rarely forms a large percentage of the ore, and in many other cases the metallic constituent is entirely subordinate.

The author states that "the miner considers an ore to be a mineral with a metallic base, occurring in sufficient abundance to be economically valuable; but from the scientific standpoint, a grain of magnetite in a granite rock is as much an ore as a bed of this mineral." The term ore is essentially a technical mining term, and has no scientific significance whatever. When a metal can be profitably extracted from a certain material, that material becomes an ore; but other materials may contain just as much of the same metal, and yet, on account of their mineralogical or other features, they may not be commercially profitable sources of the metal, and then they are not ores. Whether a material is an ore or not, is dependent on commercial conditions, which may vary from time to time; and this very fact prevents the term from having a scientific meaning.

On page 16 the author says that "the group of silicates is extremely large, including many of the important rock-forming minerals, but as ores they are of little importance." He has evidently overlooked the fact that calamine, a hydrous silicate of zinc, is an important ore, and that garnierite, a hydrous silicate of nickel and magnesia, is the source of a large part of the nickel of commerce. The latter is the ore mined at New Caledonia, off the coast of Australia, one of the two largest nickel producing regions in the world. It also occurs in the United States. The author again overlooks this silicate when, on page 26, in enumerating the ores of nickel, he says, "nickel is obtainen from the two sulphides, millerite, niccoliferous pyrrhotite, and the arsenide niccolite." In other deposits also silicates form a minor but an important part of the ore, as in the case of chrysocolla in the copper ores of Arizona.

On page 18 the author states that, "Sometimes, though not commonly, gold occurs in iron pyrites in invisible grains." It is almost unnecessary to say that one of the most common modes of occurrence of gold is in intimate association with iron pyrites, so that this statement is extremely misleading.

On page 20 the author says: "Gold occurs in the earth in only two mineralogical forms, so far as known, one in association with tellurium, the other native, the latter being its typical occurrence and the one from which the gold in use is obtained." It is true that native gold is the source of most of the gold in use, but the telluride ores, far from producing no commercial gold, are in many mines an important source of that metal. At Cripple Creek, in Colorado, the tellurides form an important part of many of the ores, and this district produced between $2,500,000 and $3,000,000 in gold in 1893. In Boulder county, Colorado, tellurides are also of importance, and have been so for many years past, while tellurides frequently occur in still other places.

On page 22 the author, in speaking of copper, says: "Its most common occurrence, however, is as the sulphide, *chalcopyrite* ($CuFeS_2$), or copper pyrites, which is in reality a sulphide of iron and coppes combined, the proportion varying from an exceedingly cupriferous variety (chalcopyrite) to pure iron pyrites." The sulphide of copper known as copper pyrites is a definite chemical compound, with proportions of iron and copper in a definitely fixed ratio, so that the mineral cannot vary from an exceedingly cupriferous variety to pure iron pyrites. The same may also be said of other sulphides of copper.

Copper pyrites is often, and even usually, when found in nature, mechanically mixed with iron pyrites, and the relative amounts of copper pyrites and iron pyrites in a deposit may vary considerably. Different analyses of this mixture of the two minerals may, therefore, show varying proportions of copper and iron, but the composition of the copper pyrites itself is constant.

On page 23 the author speaks of the "pale yellow rust" of lead ores, and by "rust" he means doubtless the carbonate of lead formed by the action of surface agencies on the superficial parts of certain lead deposits. This product is often stained yellow or brown by the oxidation of iron pyrites, which is frequently associated with galena, the common ore of lead; but the normal color of the "rust," or carbonate of lead, is white. An oxide of lead of a yellow color may be formed when certain lead minerals are highly heated under suitable conditions, but this process would obviously be a very unusual one in nature, and the common product of the superficial alteration of galena ores is first the sulphate and then the carbonate of lead.

On page 132 the author, in speaking of iron ores, says: "The carbonate, siderite, may be considered to be a combination of iron and calcite in which the percentage of iron varies even to the point of complete replacement of the calcium." Siderite is a definite chemical compound containing iron protoxide and carbonic dioxide in fixed proportions, while calcite is also a definite chemical compound containing calcium oxide and carbonic dioxide in fixed proportions. Both siderite and calcite are isomorphous carbonates, and the two crystallize together in various proportions. The carbonate of iron, however, can in no way be called a "combination of iron and calcite."

The Lake Superior copper and iron districts, which, taken together, form one of the most important mining regions in the world, are discussed very briefly, but even the descriptions given are inaccurate. On page 210, in speaking of the Lake Superior copper ores, the author says that "in some of the mines, mineralized ores of copper are the source of the metal, but the most common ore is native copper frequently associated with native silver." The fact is that none of the copper produced in the Lake Superior region is derived from "mineralized"[1] ores of copper, but all of it is obtained from native copper. The native copper is sometimes slightly stained green by the formation of a thin crust of carbonate of copper on its surface, but even this does not always happen, and one of the remarkable features of the Lake Superior region is the very extensive occurrence of copper in its native state. Copper sulphides are disseminated through the region, and are probably the source from which the native copper was derived in nature; but they have not been found to be themselves concentrated in commercially important quantities, and are therefore not mined. Small quantities of oxide of copper also occur, but are likewise not of present importance.

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[1] By "mineralized ores" it is supposed that the author means the ores in which the copper is combined with other elements, forming sulphides, carbonates, oxides, etc.

On page 125 Professor Tarr, in describing a section by Van Hise, showing the mode of occurrence and formation of the iron deposits in the Penokee-Gogebic range in the Lake Superior region, states that Irving and Van Hise have shown that the hematite deposits of that region were formed by a replacement of "beds of dolomitic limestone." It may be said here that the iron deposits of the Penokee-Gogebic range occur in the Upper Huronian series, which, in this district, contains no dolomitic limestones. A dolomitic limestone occurs near the base of the Lower Huronian of the district, but it has no connection whatsoever with the Penokee-Gogebic iron deposits. Van Hise clearly states, in his various publications on this subject, that the iron deposits of the Penokee Gogebic range represent a replacement of a siliceous rock containing carbonate of iron and other carbonates, and designated by him as cherty iron carbonate. One of the principal points which Van Hise brings out in the discussion of his theory for the formation of these deposits is that the change has been largely an oxidation of the iron carbonate and a replacement of silica by oxide of iron. Professor Tarr also gives a geological section illustrating the occurrence of the Penokee-Gogebic ores, and designated by him as "modified from Irving and Van Hise." In the legend below the section, the iron deposits are referred to as "iron ore, replacing ferruginous chert"—a statement not at all in accord with Professor Tarr's text just cited. It is, moreover, difficult to understand on what basis an author, who has never studied a region, has "modified" the geological sections of other authors who have spent years in investigating that region.

The errors in this book that have already been pointed out are only a few among the many that might be mentioned, but they serve to show the want of familiarity with the subject and the inaccuracies prevalent throughout the volume.

In a work of this kind, brief and concise statements are necessary in order to confine the volume to its proper size, but the different subjects should receive discussion more or less briefly according to their importance, and the more important subjects should not be neglected while the less important are treated in detail. The latter course not only prevents a book from containing as much useful information as it might otherwise do, but it also makes it extremely misleading to the student, for it gives him an erroneous idea of the relative importance of the different branches of the subject. Thus, in the present volume, the discussion of iron covers 27 pages. Of this number only 18 pages are given to the description of iron deposits proper, while nine pages are given to the enumeration of statistics which might have been condensed into a third of that space. Moreover, the great iron region of the Lake Superior country, which supplies more than two-thirds of the iron ore used in the United States, receives only three pages of treatment. The copper region of the Lake Superior country receives only four pages, and the copper and silver region of Butte City, Montana, one of the most celebrated mining localities in the world, receives only two pages; while other much less important subjects receive many pages. Such inequalities might be justifiable if the geology of certain regions were so simple that it could be described in a few words, even though the commercial features might be of great importance. In the instances cited, however, this is not the case.

Economic geology, including both the subject of ore deposits and other subjects which properly belong to this branch of geology, is in much need of accurate geological work and careful discussion. This is especially true in the United States, which is preëminently the mining region of the world; and it is unfortunate that a treatise relating mostly to the ore deposits of this country should have failed to give the subject thorough treatment. The volume, though in some parts it need not be severely criticised, shows in most parts an extremely superficial knowledge of economic geology, and contains many the errors in statements regarding the mineralogical nature of ores and geological nature of ore deposits; it shows a want of knowledge of the commercial features of the various mining industries, and it bears evidence of a lack of the sense of proportion in the amount of space given to different subjects.

R. A. F. PENROSE, JR.